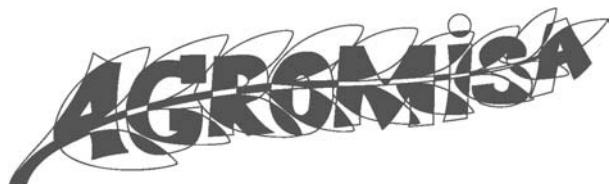


Fodder Trees



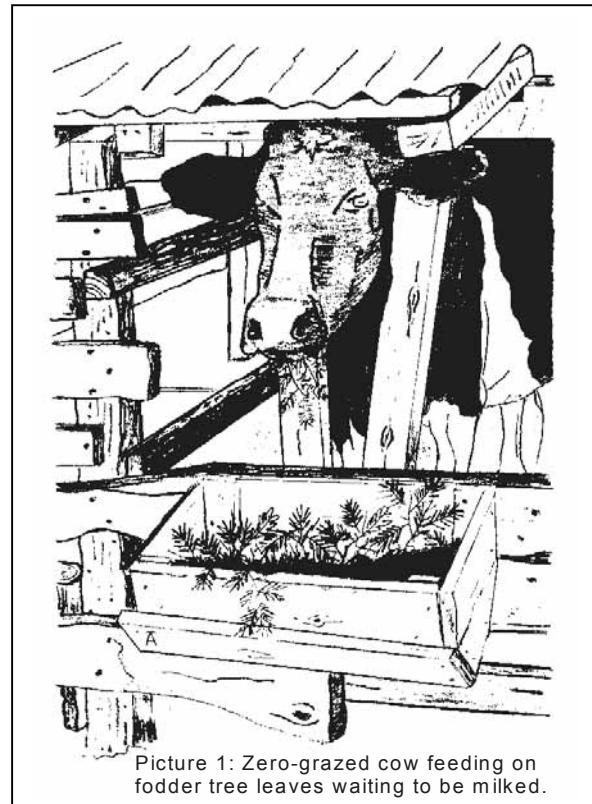
André van Tol

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The Agrobrief 'FODDER TREES' deals with trees and shrubs mainly or partially grown to provide fodder for livestock. The information in this brochure helps extension workers in the tropics to advise farmers about feeding fodder tree leaves to cattle, goats and sheep. It describes in short how farmers can benefit from fodder trees and which type of tree, how many and where they should be planted. It also deals with harvesting, feeding rations and the harmful side effects, when tree leaves are fed in excess to the animals.

1. Why are Fodder Trees important?

Many small-scale farmers in the tropics keep livestock, particularly cattle, goats and sheep. The animals play an important role: they provide meat, milk, leather or wool, traction to plow fields and manure to fertilize crops. Through selling some of the animals or their products farmers also earn cash money. Farmers expect quality produce from their animals. Therefore the animals need quality feed and water in order to live, grow, work or produce milk. When they are well fed the animal will be in good condition and the farmers benefit best from their animals. Feeds, like grass and leaves, contain a water- and a non-water-part, the latter being called 'Dry Matter' (DM). The 'Dry Matter' contains 'energy' (carbo-hydrates), 'protein' and other substances (like 'minerals'). Even when a cow, goat or sheep is not producing milk, it needs energy to breathe, walk and maintain all kinds of body processes, and it needs protein to grow. This basic need of feed, which is necessary just to maintain a stable condition of the body, is called 'maintenance requirements'. For young animals to grow fast or animals to produce high milk yields, extra energy and protein is needed above the daily maintenance requirements. However, due to dry periods and cash problems, feed shortage is often experienced and feeds of low quality are used. The farm animals are not able to get enough energy and protein to grow (fast) or to produce (extra) milk. Sometimes animals are even fed less than the daily 'maintenance requirements' and as a result will be in a bad condition. Fodder trees and shrubs become then important as a source of energy and protein to keep the animal's body healthy, improve growth rates and even increase milk and wool production.



Picture 1: Zero-grazed cow feeding on fodder tree leaves waiting to be milked.

Three main reasons for growing fodder trees

1. Fodder trees provide a cheap protein source: For growth and milk production, protein is a major requirement in the daily feeding ration. But live-stock is often fed on low-quality roughage or grasses, such as napier-grass, which contain low amounts of protein. Therefore it is recommended to supplement the basic diet of, for example, dairy cows with concentrates (dairy meal), which contain

enough protein (about 160 gram in 1 kg). However, farmers generally don't follow this advice. They lack cash to buy concentrates, and they argue that its nutritive value is suspect and highly variable, and that it is difficult or expensive to transport it from the markets to their homes. Fodder tree leaves contain high quantities of protein, ranging from 10-30% of the 'Dry Matter' (DM). For example: 1 kg fresh leaves, with 25% DM (which is 250 gram, depending on the maturity of the leaves), contains 25-75 gram protein. Fodder tree leaves can thus replace concentrates to a great extent and become a cheap source of protein supplementation. However, the availability and quality of tree leaves depends on the season, while concentrates might be available year round.

2. Fodder tree leaves used as a dry season supplement: During the dry periods trees and shrubs remain green for a longer period than grasses because of their deeper rooting system, which can tap water beyond the reach of grass roots. So when the availability of grass decreases as it dries up and its protein content declines, the fodder trees are still green and can provide the required energy and protein

3. Fodder trees also have other uses: Some fodder tree species improve soil fertility by providing green mulch or by fixing nitrogen or they provide construction material, firewood, shelter, shade or edible pods. For more information about other uses, read AgroDok-series No. 16: 'Agroforestry' (see Appendix 'Further readings'). Warning: Some trees may contain a certain amount of toxic substances. Therefore their leaves should be fed in limited quantities only (see Part 7)!

2. Which trees are suitable as fodder trees

Not all types of trees and shrubs can be used for fodder production. When farmers select trees for fodder production they should look for several characteristics:

Leaves and pods should have a high nutritive value, which means that they contain a lot of protein.

Trees should produce many leaves and regrow easily after frequent pruning.

Edible parts of the tree should not contain (too much) toxins.

Tree leaves need to have a high palatability, which means that the animals like to eat them and can digest them well.

Trees must preferably be tolerant to drought, pests and diseases.

Trees should not compete too much with other crops. For example, good fodder trees should form deep roots in order to avoid competition with shallow rooted crops for water.

Indigenous and exotic fodder trees

Not all types of fodder trees and shrubs perform well in each area. Different types of trees and shrubs are suited to different climates (depending on temperature and amount of rainfall), altitudes and soil types. Therefore it is important to select those types, which are suitable for the area. Species, which are most suited to the local climate, are trees and shrubs, which originated from the area. They are called indigenous species. But exotic species can also do well in certain areas under favourable conditions. When certain species are grown outside the region from where they originated they are called exotic species. Growing exotic species might create risks because they are not or less adapted to the local climate. This means they might not have evolved surviving strategies during periodic adverse climatic conditions (for example droughts) like the local trees. Exotic trees also lack natural predators for the exotic pests and diseases, which are often imported with the exotic tree species. But when local pests attack the local species there should be natural predators of these pests as well. The natural predators kill the pests and reduce the damage to an insignificant level. Another advantage of growing indigenous trees is that seeds or cuttings are commonly available.

Since it is impossible to describe all fodder trees and shrubs for all parts of the world, a list of Useful addresses is added at the end of this brochure (see Appendix). Here, several organizations and institutes are mentioned, which advise in all kinds of Agroforestry practices and know which types of indigenous and exotic trees are suitable for fodder production in which region. On the internet ICRAF has published a tree-database, which gives information about more than 500 tree species (www.worldagroforestrycentre.org). In this brochure only four types of trees are described.

One should consider the following advice when choosing a suitable fodder tree:

- 1. Consult experienced people:** It is recommended to consult the local Agroforestry institute, extension worker or experienced farmers in the neighbourhood before selecting and planting fodder trees. They know which types of trees are most suitable to be fed to the animals.
- 2. Plant different species of fodder trees:** In case of a pest or disease outbreak, only one type of tree will be affected, while the others still produce quality fodder.
- 3. Choose exotic as well as indigenous trees:** Plant both indigenous and exotic tree species. Indigenous fodder trees tolerate the local climatic conditions and the presence of certain pests and diseases better than exotic trees. Therefore they will do better than exotic species. But some exotic species can produce more fodder than some indigenous species when the conditions are favourable.

Commonly grown fodder trees:

Four types of fodder trees are commonly grown in many parts of the world: Calliandra, Gliricidia, Leucaena and Sesbania. Apart from some Sesbania species, which are believed to be native to Asia and Africa, the mentioned types are indigenous for South or Central America. But they have proven to grow quite well in many areas outside the region from where they originate. These four types are all leguminous. This means that they are able to fix nitrogen from the air. The nitrogen is fixed in small nodules on the roots. When a tree is pruned or cut, this nitrogen will be released into the soil. In this way leguminous trees are able to improve soil fertility.

<p>Calliandra calothyrsus:</p> <p>The tree can only be used by farmers in the humid and sub-humid zone with a minimum annual rainfall of 700 mm (see table below). It grows well on a wide range of soil types but prefers light textured, slightly acidic soils. It can tolerate infertile and compacted or poorly aerated soils but does not tolerate waterlogged and alkaline soils.</p> <p><i>Calliandra</i> is affected by a few pests only but is often attacked by ants. The seed pretreatment procedure is to immerse in hot water, allow cooling and soaking for 12-24 hours.</p>	<p>Gliricidia sepium:</p> <p>It performs well in areas with as little as 600 mm rainfall annually. The tree grows in a variety of soils, both acidic and low in fertility, mainly in humid coast lowlands or lake basins (maximum altitude 1,600 meters above sea level). It tolerates waterlogged soils but will not perform in regions with low temperatures. Temperatures below 15 degrees Celsius cause loss of foliage and poor growth. When seeds are not fresh, soaking overnight in hot water is required and planting should proceed immediately thereafter.</p>
<p>Leucaena leucocephala:</p> <p>This tree is found from lowlands up to 2100 meter. It requires an annual rainfall of 650-1500 mm, but can be found in drier and wetter regions.</p> <p>The species is not suited to acid soils or to waterlogged conditions. <i>Leucaena leucocephala</i> is a popular fodder species but it is sometimes attacked by a pest called 'Leucaena psyllid' (<i>Heteropsylla cubana</i>). Other species like <i>Leucaena diversifolia</i>, <i>Leucaena esculenta</i> and <i>Leucaena pallida</i> show some degree of tolerance for this pest.</p> <p>Seed pretreatment involves soaking in hot water for 2 minutes.</p>	<p>Sesbania sesban:</p> <p>This tree tolerates waterlogged and poor soils. It has been successfully grown in arid areas with only 500 mm annual rainfall, but it prefers a rainfall up to 2000 mm. Yields are lower when the soil is more acid. <i>Sesbania sesban</i> and <i>S. grandiflora</i> have a high nutritive value but they do not withstand intensive cutting. Because both species produce a lot of seeds and are easily established by direct seeding of untreated seeds, resowing after harvesting might be better than allowing it to regrow. In this regard they could be sown on fallow land, to improve soil fertility.</p>

Commonly grown fodder trees	Minimum rainfall	Maximum altitude	Acid soils	Waterlogged soils
Calliandra calothyrsus	700 mm	2200 m	tolerant	not tolerant
Gliricidia sepium	600 mm	1600 m	tolerant	tolerant
Leucaena leucocephala	650 mm	2100 m	not tolerant	not tolerant
Sesbania sesban	500 mm	2300 m	not tolerant	tolerant

3. How many trees should be planted?

Before the number of fodder trees to be planted on a farm is determined, the farmer has to answer the following questions:

1. What type and number of animals is kept at the farm and how much feed do they need?
2. What type of feed is available and how much feed is in short in which season?
3. How many fodder tree leaves are necessary to minimize the feed shortage?
4. What is the expected leaf production of a fodder tree?

NB: Protein (often the term 'crude protein' (CP) is used) is often the limited factor in feed, while energy can be found in many types of feed. The examples described in this part therefore focus mainly on reaching the protein requirements of the animals.

STEP 1: Type and number of animals is kept at the farm and how much feed do they need?

First of all the farmer should know the type and number of animals kept at a farm. These facts determine how much protein (and energy) is required. Body weight and growth rate are important factors in establishing the protein requirements of the animals. Some examples: A goat or sheep of 10 kg needs, for a growth rate of 50 gram per day (g/day), about 23 g/day crude protein. For a growth rate of 100 g/day the same animal needs about 33 g/day. But when it has a weight of 30 kg the daily crude protein needs for both growth rates are 40 and 50 gram respectively.

A local adult cow of 350 kg needs about 340 gram crude protein for the daily maintenance requirements. A big crossbred cow of 500 kg needs more, about 430 g/day. The purpose for which an animal is kept also determines the required protein consumption. If the same crossbred cow is kept for milk production protein requirements should be even higher, about 640 g/day (depending on the level of production). The level of activity determines the amount of feed too. Does the animal spend energy foraging for food or is it being served in a compound or shed?

STEP 2:What type of feed is available and how much feed is in short in which season?

To know if the animals consume enough protein (and energy) the farmer has to define for each season what type and how much feed is normally fed. Besides grass, this can be leftovers of crops such as leaves of maize, cowpeas and banana, but also cereals, pulses, oil seeds or concentrates. For each type of feed protein contents are known. The table below shows how much gram crude protein an animal consumes when eating 1 kg of a certain feed type (depending on the DM-content: A crop, which is young has a lower DM-content and higher protein-content in comparison with an old and mature crop). Now the farmer is able to calculate how much protein the defined feed rations contain. Then the farmer compares this with the protein requirements and determines if the farm animals lack protein (see the example in step 3). More detailed information about feeding of goats and dairy cattle is written in the Agrodek-series: No. 07: 'Goat keeping in the tropics' and No. 14: 'Dairy cattle husbandry' (see Appendix 'Further Readings' and section 'Agromisa').

Crude Protein (g/kg)		Crude Protein (g/kg grain)		Crude Protein (g/kg grain)	
Young grass (18%DM)	25	Maize (87%DM)	65	Field beans (87%DM)	205
Old grass (54%DM)	0	Millet (88%DM)	80	Chick pea (91%DM)	150
Good hay (85%DM)	50	Sorghum (87%DM)	55	Cow pea (88%DM)	190
Rice straw (90%DM)	5	Rice (husked, 89%DM)	75	Groundnut (93%DM)	240
Maize stover (82%DM)	36	Cottonseed (h., 92%DM)	300	Soya bean (89%DM)	300
Sorghum stover (87%DM)	44	Sunflower (h., 92%DM)	225		

STEP 3: What quantity of fodder tree leaves is necessary to minimize the feed shortage?

Now the farmer knows the daily feed (protein) shortage, the farmer needs to know how many fodder tree leaves need to be supplemented for the animal to consume the daily protein requirements. Therefore information is needed about how much protein the tree leaves contain.

The four mentioned fodder trees in this Agrobrief contain a high quantity of protein. It ranges from 50-75 gram in 1 kg of fresh leaves (with 25% DM), depending on the maturity of the leaves.

Example:

Suppose a dairy cow of 500 kg feeds on old grass and the farmer supplements about 20 kg of young napier-grass each day during a certain season. No protein is found in old grass but each kilogram of napier-grass contains 18 grams of crude protein. Therefore the cow consumes ($20 \times 18 =$) 360 gram of crude protein. However, the cow requires about 640 gram, thus it lacks ($640 - 360 =$) 280 grams of crude protein. Assuming that each kilogram of fresh fodder tree leaves contains 50 grams of crude protein, ($280 / 50 =$) 5½ kg of fodder tree leaves is required to supplement to the required protein level.

Directives for fodder tree leaf supplements:

Most farmers find it difficult to determine the protein content of feed consumed daily by the animals, especially when the animals are not zero-grazed. It is also not an easy task to calculate how many tree leaves should be fed to the animals to compensate feed shortage. Therefore the examples below are given, based on experiments (see section 'References'). This serves as a guideline for calculating fodder tree leaf supplements.

Dairy cows: It is recommended that a crossbred dairy cow be fed about 4 kg of dairy meal a day (containing 16% crude protein = 640 gram) to supplement a basic diet of grass in order to have a good milk production. To know how much fodder is required to feed the cow without buying dairy meal, one needs to know how many kg's of fodder tree leaves can replace the amount of protein in dairy meal. Research showed that 3 kg of fresh Calliandra leaves has the same effect on the milk production as about 1 kg of dairy meal. This means that the total number of trees should produce at least 12 kg fresh leaves daily. However, a farmer should be cautious when a cow is fed more than 9 kg (see Part 7)! (NB: The total amount of Dry Matter required by a milking cow is 2½-3% of its body weight or about 10-12% for fresh material.)

Oxen: Indications of another study are that 2 kg/day of fresh Leucaena will result in a notable improvement in the body condition of local oxen. Better physical condition results in an improved ability to do heavy work during the period of land preparation.

Dairy goats: Goats with a bodyweight of 20-40 kg need about 40-60 grams of crude protein daily for maintenance requirements only. Depending on the level of activity they need 25-75% more protein if they have to forage for food in rangeland. A mature doe (female goat) needs an additional amount of 80 grams of crude protein in its late pregnancy. After giving birth the additional protein requirements for milk production are about 70 grams for each liter of milk to be produced. Thus, for a zero-grazed dairy goat of 20 kg to produce 1 liter of milk it needs ($40 + 70 =$) 110 grams of crude protein. Since 3 kg of Calliandra tree leaves replaces 160 grams of crude protein (see directives for dairy cows) the dairy goat needs to be supplemented with about 2 kg of fresh leaves daily. However, the maximum fodder supplement should not exceed 50% of the total ration. The total daily ration of a goat of 20 kg is about 2 kg (10% of its own bodyweight for fresh material). Therefore a daily supplement of 1 kg fresh Calliandra leaves should be taken as a directive.

Young goats: Research was done with three groups of 10 young local goats of about 8 months. All groups grazed at daytime on natural range during one year. At night one group was supplemented with Leucaena and another group with Sesbania leaves. The young goats ate about 80 grams/day of tree leaves each. The last group of young goats was not supplemented with fodder tree leaves. (On average a young goat manages to eat 6% of its own body weight per day.) The result of the research was that each goat, which was supplemented with fodder tree leaves, grew on average 27 grams a day during the year. The goats, which were not supplemented, gained on average 6 grams a day. Thus, to feed 1 young goat, the fodder trees at the farm should produce together 80-100 grams of fresh leaves daily.

Sheep: Research showed that when the grass diet of sheep is supplemented with 10-30% Gliricidia sepium, it improves the survival of ewes and lambs, lambing rate, birth weight and growth of lambs. The daily intake of 'Dry Matter' (DM) is about 2.5% of the sheep's own body weight for good-quality grass. When a sheep of 32 kg feeds on young grass (which contains 20% DM) it will eat about ($32 \times 2.5\% \times 100 / 20 =$) 4 kg of grass/day. Thus the sheep can be supplemented with 400 to 1200 grams of fresh fodder tree leaves daily.

STEP 4: What is the expected leaf production of a fodder tree?

There is a large variation in foliage production of fodder trees. Besides the type of tree the yield of a tree also depends on:-

Age: just established trees and old trees produce a low amount of fodder.

Climatic conditions and season (like temperature and rainfall): when conditions are too cold, too hot, too dry or too wet, trees will produce less fodder.

Soil fertility: trees planted in infertile soils produce less fodder, but production can be improved by adding fertilizer and/or manure, especially during the early stages of establishment.

Overall tree management: a tree that is pruned every 4 months will produce less fodder than a tree that is pruned every 6 months only. The cutting height also affects the production of the tree. If a tree is cut too low the tree is not able to regrow fast.

That different types and ages of trees produce different quantities of leaves is shown by this example: In the sub-humid highlands of Kenya leaf production of hedges maintained at a height of 0.5 meter were compared for Leucaena leucocephala, Calliandra calothrysus and Sesbania sesban. In the first year the fresh yields were 11, 17 and 20 ton per hectare (t/ha) respectively. However, in the following 8 months Calliandra had the highest yield (36 t/ha), followed by Leucaena (24 t/ha). Sesbania had the lowest yield (10 t/ha), most probably caused by pruning stress.(Explanation of units:1 ton = 1000 kg and 1 kg = 1000 gram.1 hectare = 2.5 acres or 10,000 square meters.1 meter = 100 cm or 3.3 feet and 1 foot = 30 cm.)

Annual fresh leaf production:

Though the yield of a tree depends on many factors, estimates are given in the accompanying table for four tree species. The maximum production being recorded under good soil conditions, the right altitude and proper management.

Type of tree	Annual fresh leaf production for 1 tree
Calliandra	1.8 – 4.8 kg
Gliricidia	1.5 – 2.5 kg
Leucaena	1.8 – 4.8 kg
Sesbania	4.5 – 7.5 kg

Calculating the number of fodder trees to be planted on a farm:

Now we know more about the amount of fodder tree leaves needed, and the yield of different types of trees, it is possible to calculate the total number of trees to be planted on a farm. The number of trees to be planted is now calculated in the following steps (see table below).

1. First, the amount of fresh leaves needed for one day are multiplied by the total number of days (365) in one year to get the amount of leaves, which is required during a whole year.
2. The annual fresh leaf requirements are then divided by the minimum 'annual fresh leaf production' of the tree species, which the farmer likes to plant. It is also divided by the maximum production per tree. The outcome is the minimum and maximum number of trees to be planted at the farm to feed the number of animals as stated in the examples.
3. At a 'double zig-zag spacing' of 0.15 m (see Part 4), the length of the hedge is also calculated by multiplying the spacing with the minimum and maximum number of trees.

Examples:

In order to understand how the total number of fodder trees is calculated examples are given of five different farmers. They keep different types and numbers of animals and supplement the animals with fodder tree leaves as stated in the directives:

Farmer A has one crossbred dairy cow and likes to replace 3 kg of the daily required amount of dairy meal. The Calliandra tree leaf production at the farm should be at least 9 kg daily.

Farmer B has two oxen to plough the fields. The foliage production of the Leucaena trees should be 4 kg daily in order to keep the animals strong and healthy.

Farmer C has two mature dairy goats, which produce each 1 liter of milk. The Calliandra trees at the farm should produce 2 kg of fresh leaves daily.

Farmer D has a group of ten young goats. The Sesbania (or Leucaena) trees at the farm should produce about 1 kg of fresh leaves daily.

Farmer E has a group of five mature sheep with an average weight of 30 kg each. The Gliricidia trees at the farm should produce about 5 kg of fresh leaves daily.

	Number & type of animals	Fresh leaves needed in 1 day	Fresh leaves needed in 1 year	Min. & Max. number of trees	Length of hedge
A	1 dairy cow	9 kg Calliandra	(9x365=) 3285 kg	(3285/4.8=) 685 (3285/1.8=) 1825	100 - 275 m.
B	2 oxen	4 kg Leucaena	(4x365=) 1460 kg	(1460/4.8=) 305 (1460/1.8=) 810	45 - 120 m.
C	2 dairy goats	4 kg Calliandra	(4x365=) 1460 kg	(1460/4.8=) 305 (1460/1.8=) 810	45 - 120 m.
D	10 young goats	1 kg Sesbania	(1x365=) 365 kg	(365/7.5=) 50 (365/4.5=) 80	8 - 12 m.
E	5 sheep	5 kg Gliricidia	(5x365=) 1825 kg	(1825/2.5=) 730 (1825/1.5=) 1215	110 - 180 m.

One should consider the following advices when using these examples:

1. In the above-mentioned method for calculating the required number of trees to feed the animals all year round, it is assumed that the trees produce leaves continuously. In fact leaf production will fluctuate during the year. In dry periods the production will be less than in the rainy season. The animals also do not produce to their full capacity year round and thus do not always need to be supplemented.
2. The maximum number of trees needs to be planted in areas where soils are poorer and rainfall is less than average. Yields will increase by adding manure or through irrigation. Also keep in mind to plant different fodder tree species!
3. The described method is a good start for farmers, who like to plant fodder trees for the first time. As farmers gain more experience they will be able to adjust the supplements of tree leaves to the specific needs of their animals.
4. Farmers are advised to grow a few more trees for seed production. The availability of seeds might be low and when available expensive. Leave these trees unpruned and collect the mature pods before the seeds drop. The seeds can also be sold to earn some cash.



Figure 2: Branches from fodder trees, which are intercropped with napier-grass, are pruned from the base upwards.

4. Where to plant trees on the farm

Because of the limited acreage of most farms it is best to integrate fodder trees and shrubs into the existing cropping system, rather than planting the tree in pure-stand (mono-culture) fodder banks. The AgroDok-series about agroforestry (see Appendix 'Further Readings') shows examples how trees can be grown easily on the farm without necessarily interfering with the land needed for crop production.

A typical farm of about 1½ hectare (or 4 acre) has a farm boundary (circum-ference) of about 500 meter and also has space along contours and in between other crops or trees, to accom-modate more than a thousand fodder trees.

It is wise to select first the site where fodder trees will be planted before buying them or raising seedlings in a small tree-nursery at the farm.

The best areas to plant fodder trees or shrubs:

Intercropping trees with Napier-grass: There appears to be a potential to increase fodder production through the introduction of legume trees into existing Napier grass plots. Research shows that the fodder yields for legume trees and grasses, grown in combination, are higher than for the pure hedgerows. The total yield of protein is also much higher from the combination than from grass or fodder trees grown separate. When intercropping is practiced fodder trees should be planted in hedgerows spaced 5 meters apart. The spacing between the seedlings in a row (single line) should be 30 cm in humid areas to 250 cm in dry areas. To avoid low yields due to competition for water and light trees should be kept small through pruning and cutting.

Planting trees on boundaries: The boundary between farms or homesteads is often separated by shrubs or barbed wire. This strip of ground can be better utilized by planting fodder trees. This can be done in a double zigzag line at a spacing of 30x30 cm (see picture 3). In this way a tree is planted after every 15 cm of the boundary.

Soil conservation structures: Fodder trees can be planted on the upper or lower side of soil conservation structures such as terraces or contour ridges. The best site is the lower side where the moisture content will be higher. A mixture of Napier-grass and/or other grasses with fodder trees will also strengthen the soil conservation structures.

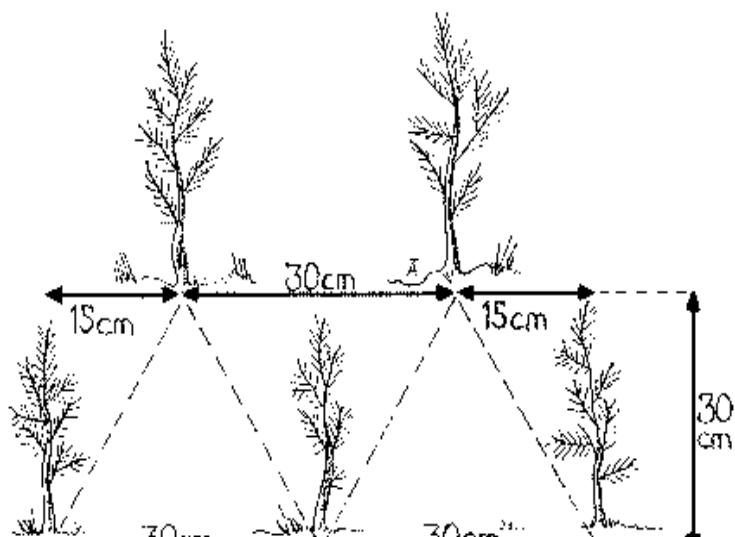


Figure 3. Spacing trees on the boundary in a zigzag design

5. How to harvest fodder trees?

This AgroBrief does not deal with tree management, except for harvesting the tree leaves. For information about sowing tree seeds, weeding, transplanting seedlings, etc, see AgroDok-series No. 19: '*Propagating and planting trees*' (see Appendix 'Further Readings').

Harvesting techniques:

The following techniques can be used when harvesting leaves from the fodder trees:

1. 'Pruning' and 'lopping': These are methods in which the side branches of a tree are cut. Pruning is different from lopping in that the branches are cut from the base (see picture 2). Lopping is not always done starting from the lower part, but can be done more haphazardly.

'Pollarding': If all branches and the crown of a tree are cut off but the whole stem is left (about 2 meter), this is known as pollarding (picture 5).

'Coppicing': Many species of trees and shrubs have the ability to resprout after the whole tree has been cut. If this ability is used for regene-ration of the tree the practice is known as coppicing (see picture 4).

First pruning:

Fodder trees can only be pruned, when the thickness (diameter) of the stem at 50 cm above the ground level is 8-10 cm. The altitude, soil fertility, rainfall and the type of tree determine how fast the

tree grows and thus the period in which the stem reaches the required thickness .For fast growing trees the required diameter will in general be reached within one year.

Following prunings:

After the first pruning, the following prunings or loppings should not be done too regular, otherwise the yields per pruning and the life span of the tree will be reduced. The farmer should experiment to experience how a tree copes with a certain pruning frequency. The intervals may be longer or shorter depending on the climate, rainfall, soil fertility and altitude. In general, avoid cutting trees too often or at a low height at the beginning, during and immediately after the wet season. Too much pruning of trees during these periods exposes them to a high chance of disease attack. It is wise to let the trees grow and save the leaves for the dry season.

Harvesting fodder trees in dry areas:

In dry areas, it is useful to allow the stem to reach more than 10 cm in diameter before pruning or allowing browsing by livestock. The main root is then supposed to have grown deep enough to reach the lower water table, thus allowing the tree to get enough water during the dry season. There-after, pruning should not exceed 2-3 cuts per year to be sure that the strength of the tree is not lost.In areas with long dry seasons, water shortage can lead to the loss of fodder material, unless cutting times are chosen wisely. If the aim is to maximize the yield of fodder at the height of the dry season, experiments have shown that the final wet season cut should be made six months earlier.

Pruning tools:

Secateurs or pruning clippers is the recommended tool for pruning or lopping the trees. Much damage can be done because of bad pruning techniques such as pruning with a machete. When the branches are cut at the base with a machete, a large gash is left. This causes a 'dieback' and has a negative effect on the regrowth of the tree. If the farmer has only a machete for pruning, the cut should be upward (from the underside up) not downward. Be sure that the machete is very sharp!

Calliandra: The first pruning after planting is done at about 12 months. Then it can be cut 3-5 times a year down to a height of about 80-100 cm. Cutting can be done more frequently during the rains. Calliandra growth slows considerably when it is cold, so it is best to leave more time between prunings at this time. Calliandra coppices well and it is recommended cutting the tree right back to 30 cm after 3-4 years, allowing it to shoot. Cutting Calliandra six months before the dry season gives maximum yield during that season. The trees have a life span of about 10-20 years.

Gliricidia: Early seedling growth is slow but once established, growth is fast (up to 3 meter per year). The first pruning after planting is done at about 9 months. The tree tolerates lopping, coppicing and regular browsing well. Gliricidia can be pruned 3-4 times per year at a height of 30-150 cm. Pruning will stimulate leaf production.

Leucaena: It should be cut 75-100 cm above the ground every 2-4 months after the first pruning (9 months after planting). Leucaena is a vigorous coppicer and responds well to pollarding. Coppiced stems sprout 5-15 branches, depending on the diameter of the cut surface, and 1-4 stems dominate after a year of regrowth. Leucaena can produce well for 10 to 20 years or even up to 35 years.

Sesbania: The first pruning after planting is done at about 12 months. Then pruning 3-5 times per year at a height of 50-100 cm above the ground is recommended. Coppicing below 50 cm will reduce yields, strength and life span of the trees. Sesbania sesban has a short life span. It may start dying even after two years from time of establishment. Varieties as Sesbania grandiflora, may live for more than 20 years. This variety however, may not do well in highlands.

6. How to feed fodder-trees to the animals

The part of the trees fed to livestock is usually leaves, but pods, seeds and small twigs may also be fed. In general, the animals like fodder tree leaves, though they may have to get used to some species.

Browsing or ‘cut-and-carry’: Fodder tree leaves can be browsed or ‘cut-and-carried’ to stall-fed (zero-grazed) animals. Browsing is possible but it should be done in a rotational manner. This means that the trees are browsed for a couple of days and left for six or more weeks to recover. Overgrazing should be avoided otherwise fodder trees will die! The cut-and-carry system is recommended even though it involves a lot of work. For most tree species, the fodder leaves should be fed to the animals within an hour of harvesting. Pruning, coppicing and pollarding is common in the sub-humid zones. In the medium and dry zone browsing is much more common.

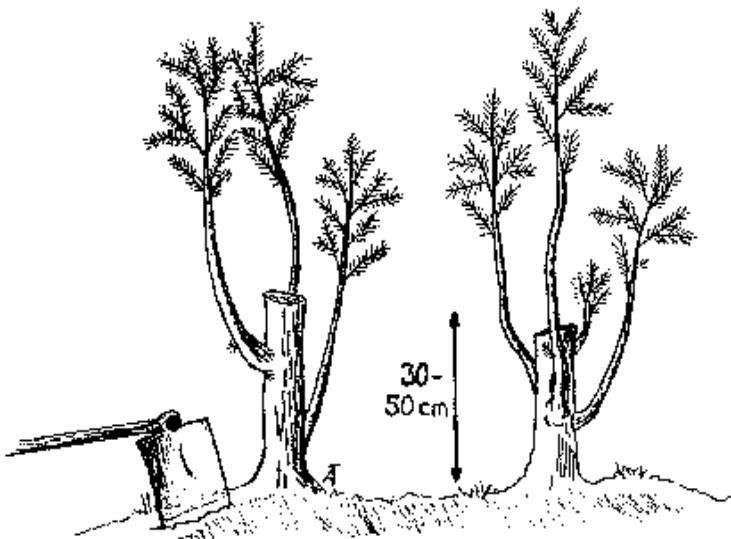


Figure 4: Trees have the ability to resprout after coppicing

Mixture of napier-grass and fodder trees: Napier-grass can be fed as much as the animal can eat. In addition to napier-grass, fresh fodder tree leaves can be fed in limited quantities as mentioned in Part 3 (also see Part 7!).

When to feed fodder trees? If there are plenty of fodder trees available at the farm the leaves can be fed to the animal throughout the year in limited quantities (see Part 7). If there are a limited number of trees, it is recommended to feed a dairy cow, dairy goat and sheep the month before and the month after giving birth. Oxen should be fed one or two months before and during the period of land preparation.

Example of a fodder tree diet for dairy cows: To the napier-grass diet of a crossbred dairy cow 8 kg of fresh fodder tree leaves can be added. This mixture provides for body maintenance and production of 10 liter of milk or more, depending on the type (genetic potential) of the cow and the quality of napier-grass. If 2½ kg maize germ is added to this mixture, on a daily basis, it will maximize the benefit from the use of fodder tree leaves. When this ration is fed to the crossbred cow in its early lactation, it might produce about 15 litre of milk per day (depending on genotype and management conditions).

Calliandra: Its digestibility declines quickly once it is cut and should therefore be fed to the animals within an hour of harvesting. Farmers who participated in experiments with Calliandra said that the quality of the milk improved. It becomes more concentrated and increases the butterfat content, producing a thick cream layer at the top after boiling. They also said that their cows preferred the foliage over protein concentrates because of its palatability (taste).

Gliricidia: Farmers sometimes complain that animals do not like Gliricidia leaves. This is because of the strong odor, which occurs when the leaves are crushed. Wilting or drying for 24 hours between cutting and feeding appears to reduce the odor of the leaves. It has been reported that animals, which first refused Gliricidia became used to it in a few days, after which it was readily consumed.

Leucaena: Cows with a high Leucaena diet may produce tainted milk. This can be avoided by keeping them away from the leaves for two hours before milking. Pasteurization also removes the taint.

Sesbania: The leaves and tender branches of Sesbania have a high digestibility. The species may become a weed and sometimes attracts soil nematodes, which also attack other crops.

7. Are there harmful side-effects?

Trees and shrubs have many ways to protect themselves from being eaten by herbivores (plant eating animals), for example through extremely hard thorns or spines and toxic compounds. The toxic compounds can have a negative health effect and even can cause death. Many plants also contain tannin, a certain substance, which is responsible for reduced digestibility of feed. It fixes protein, preventing it from being degraded by rumen micro organisms, or from being absorbed in the intestinal duct of the farm animal. This means that the protein in the feed can not be used by the animal for growth or milk production. Farmers are therefore cautioned on the amount of fodder tree leaves, which they include in the daily ration of cows, goats and sheep. This is because it could be harmful to the animals when fodder tree leaves are consumed in excess. Screening tree and shrub species for harmful tannins and toxins is very difficult. Many of these harmful ingredients are very difficult to identify. Therefore it is wise to get information from extension workers or farmers who have experience in feeding tree leaves to their animals. They know if certain types of trees are harmful to livestock and what quantities can be used in the daily ration of animals.

Some fodder tree leaves are toxic to horses, chicken, rabbits and pigs. Do not feed fodder tree leaves to these animals before more information is obtained!

Maximum quantities of fodder to be fed:

For all animals, the advice is to feed small quantities and increase the amount fed over time to quantities recommended as mentioned below:

Calliandra: There is no side effect known of using Calliandra in low quantities. It contains however tannin, which can reduce digestibility. To avoid this, leaves should be fed immediately after cutting. Feed a maximum of 3-4 kg for heifers and 8-9 kg for dairy cows per day. Sheep and goats can eat a mixture containing fodder tree leaves up to 50% of their ration.

Gliricidia: It is normally recommended, when feeding cattle, goats and sheep, to use fresh Gliricidia leaves at levels of 10-30% of the ration weight, with either grass or other roughages.

Leucaena: This tree contains a toxin called 'mimosine', which is harmful when consumed in large quantities. Overfeeding with leaves, young twigs and pods may lead to hair loss, low weight gains, low birth weight and infertility. Quantities to be fed to the animals are recommended as follows: sheep and goats 30-50% and cattle 10-30% of the total amount of feed consumed daily.

Sesbania: This fodder tree is only harmful when fed to livestock in excess. It contains 'saponin', a poison, which when consumed in excess, may cause bloat. To avoid the adverse effect of overfeeding with Sesbania, the amount included in the diet should not exceed 30% of the total daily amount of feed consumed by the animal.

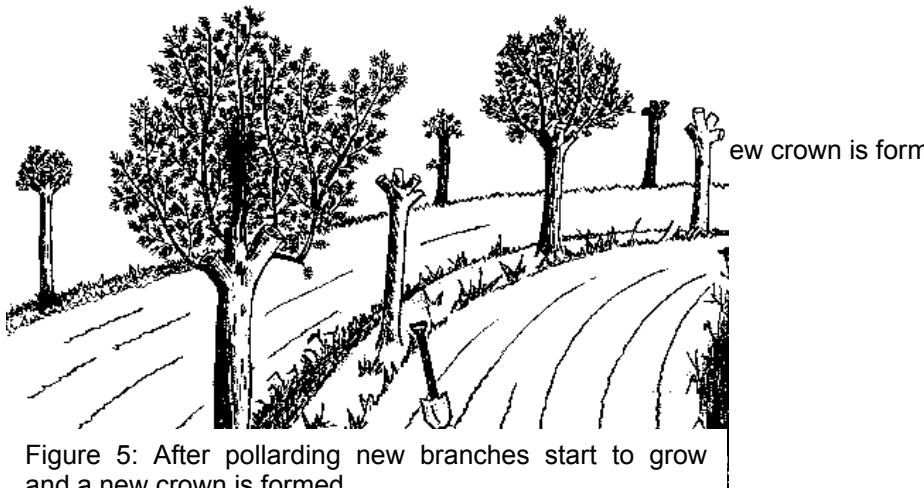


Figure 5: After pollarding new branches start to grow and a new crown is formed.

References:

For more and specific information about fodder trees see the Appendix 'Further readings' at the end of this brochure. Besides some recent scientific articles and the tree-database of ICRAF on the internet, the following references have been used to write this brochure:

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About Agromisa

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Address:

Agromisa, P.O. Box 41
6700 AA Wageningen
The Netherlands

E-mail: agromisa@agromisa.org

website: www.agromisa.org

Fax: +31 317 419 178

Appendices

Useful addresses (list of organizations and institutes to get information about agroforestry practices)

Further readings (list of books about using fodder trees in farming systems)